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**Department of ……………………….**

Engineering

Mechanic

**College of ……………………………….**

Salahaddin - Erbil

**University of ………………………….**

Control and Measurement

**Subject: ………………………………….**

**Course Book –** Spring Semester – Bologna System

**Lecturer's name Ph.D.,** Lect.: Chalang Hamarasheed Mohammed

**Academic Year: 2023/2024**

**Course Book**

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| **1. Course name** | **Control and measurement** |
| **2. Lecturer in charge** | **Chalang Hamarasheed Mohammed** |
| **3. Department/ College** | **Mechanic/Engineering** |
| **4. Contact** | **e-mail:** chalangb@hotmail.com**Tel: (optional)** |
| **5. Time (in hours) per week**  | **For example Theory: 12** **Practical: 6**  |
| **6. Office hours** | **28 hr/week** |
| **7. Course code** |  |
| **8. Teacher's academic profile**  | **Chalang Hamarasheed** is lecturer at Salahaddin University – Erbil/ College of Engineering/ Department of Mechanical Engineering. He has over fifteen years workshop, laboratory, lecturing and teaching experience at College of engineering / Salahaddin University – Erbil/ Kurdistan.He specializes in Control system, Hydrogenerator Control, Adaptive Control including Multiple Model Adaptive Control.Qualifications: BSc MSc Mechanical Engineering and controlling system. |
| **9. Keywords** | **Control system, Adaptive control, WMMAC, Hydrogenerator**  |
| **10. Course overview:** This class provides students with an introduction to principal concepts and methods of Automatic Control System. Topics covered in the course include modelling, block diagram and signal flow chat reduction, open and close control systems analysis; stability and performance analysis; optimising the systems, steady space basics. Students will work to formulate the models necessary to study, analyse, and design control systems through the application of these concepts, and to develop the problem-solving skills essential to good engineering practice of mechanical engineer required in theoretical and practical applications.The study of control system has numerous engineering applications. Mechanic, liquid, electric, hydraulic, gas, and thermal elements and modelling. In addition the combination with these structure elements and implementing the PID controller and its versons in the system. Moreover the sensitivity of these systems due to change in the reference and applied different type of load. Also, the analysing of the above systems through the stability and performance criteria to optimise and obtain the desire responses. , such as high-rise buildings, dams, and bridges and the static and dynamic. Nowadays, the controlling or automating system of any process is widely interested to reduce the cost and lack of human force. In other words the human activities are replaced by the controlling system or robotic. For instance, the large companies retired thousands of workers yearly. The government not need to employ the traffic police for managing the road or write summon for machine. |
| **11. Course objective:**A control system is a dynamical system that affects the behaviour of another system. Examples of control systems can be found all around, and in fact there are very few mechanical or electro-mechanical systems that do not include some kind of a feedback control device. In [robotics](http://homepage.mac.com/sami_ashhab/courses/control/lectures/lecture_1/robot.html), control design algorithms are responsible for the motion of the manipulators. In [flight applications](http://homepage.mac.com/sami_ashhab/courses/control/lectures/lecture_1/wings.html), control algorithms are designed for stabilization, altitude regulation and disturbance rejection. [Cruise control](http://homepage.mac.com/sami_ashhab/courses/control/lectures/lecture_1/cruise_control.html) is an interesting application in which the automobile's speed is set at a fixed value. In electronic amplifiers feedback is used to reduce the damaging influence of external noise. In addition, these days control systems can be found in diverse fields ranging from semiconductor manufacturing to environmental regulation.* This course is intended to present you with the basic principles and techniques for the design of feedback control systems. At this point in your study you have mastered the prerequisite topics such as dynamics and the basic mathematical tools that are needed for their analysis. Control system design relies on your knowledge in these
* Fields but also requires additional skills in system interfacing. As you will see from this course, from further electives, or from future experience, the design of feedback control systems depends on.
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| **12. Student's obligation**For the student to achieve a level of excellence in this subject, the following points should be given utmost consideration:- Class attendance on regular basis for the purpose of learning. On administrative level if the student absence rate exceeded (15 %) of the total lecture hours, the student will be expelled, i.e., when there are (2) lecture hours a week and there is (30 x 2) lectures per academic year, the total lecture hours is (60), therefore being absent for (9) hours will put the student on expel list,- Active participation in class discussions,- Reviewing the lecture notes and topics on weekly basis, noting the ambiguous points, if any, and requesting clarification during instructor office hours,- Visiting the library on regular basis and checking the Internet for other approaches or simplifications of topics and ideas, and- Giving adequate and sufficient priority to preparing for weekly, monthly and final tests. |
| **13. Forms of teaching**Due to very equations and rules driving, the essence of teaching program is presented by data-show projector with explaining on white board. All explanations of details are prepared on MS power point. There are also assignments and seasonal projects appointed to individual students or groups that help the evaluation process and also support team work effort.For the student to achieve a level of excellence in the subject, the following items should be given utmost consideration:1. Class attendance on regular basis for the purpose of learning.
2. Active participation in class discussions.
3. Reviewing the lecture notes and topics on weekly basis, noting the ambiguous points, if any, and requesting clarification during instructor office hours.
4. Visiting the library on regular basis and checking the internet for other approaches or simplifications of topics and ideas.
5. Giving adequate and sufficient priority to preparing for weekly, monthly and final tests.
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| **14. Assessment scheme**Attaining the requirements set to succeed in this model requires developing an engineering sense, related to this model, based on emergent analytical and problem solving skills and memorizing topics cannot secure success.In this model the maximum mark is (100 %). The grading system is based on the summation of two categories of evaluations:First, (40 %) of the mark is based on the academic year effort of the student which includes but is not restricted to the following:- Two ends of semester examinations (17 % x 2) = 34 %, for which the study material is set for the topics reviewed in that particular semester,- Quizzes and monthly exams (4 %), for which the study material is limited and assigned by the instructor, and- Projects and assignments (2 %), also assigned by the instructor.Active participation of the student in the classroom attendance, activities and discussions may be rewarded by the instructor for up to a limit not exceeding (2 %) as a general support margin, on the same basis for all of the students.The student’s final effort is announced (on boards) at least four days before the start of the final examinations. The students are allowed the 1st three days to file their objections and the corrections (if any) will be made during the final day (the fourth day).Second, (60 %) of the mark is based on final examination that is inclusive of the whole of the study material reviewed during the academic year and it usually occurs during the month of June.At the end of the evaluation process, if the students could not secure a minimum of (50 %), they are given a chance to repeat the final exam in September and they should be able by then to equal or exceed the (50 %) limit otherwise they will have to repeat this model during the next academic year if it did not contradict with the administrative regulations. ‌ |
| **15. Student learning outcome:**Students successfully completing this course will demonstrate the following outcomes by homework and exams: 1. An understanding of control system fundamentals, including concepts of measurment. 2. An ability to model most process in the real live.3. An ability to apply the controller to the process in both open and close loop. 4. An ability to analysis to systems responses due to change in reference or load values.  5. An ability to perform the stability analysis for system. 6. An ability to perform the performance criteria analysis for system.7. An ability to model the system in state space representation to solve the complex problem with different input, output, and states.8. An ability to design the control system with optimum performance and in a stable manner.  |
| 16. Course Reading List and References‌:▪ Key references:Text books:1- Modren Control Technology (Components & Systems)  By Delmar2- Automatic Control System By Bakshi 3- Automatic Control Engineering By FRANCI H.RAVENand any other Engineering Control book published.The core materials of the course consists of the above, articles from journals and internet, and lecture's notes, make sure you read all materials and prepare well before going for the exams.▪ Useful references:Any other control system books which are have such titles : feedback control system, modern control system and automatic control system▪ Magazines and review (internet):IEEE papers, ISI web of knowledge  |
| **17. The Topics:** | **Lecturer's name** |
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| Title of Subjects | Date |
| PART I (INTRODUCTION TO CONTROL SYSTEMS ) |
| 1. Introduction

-Introduction to Signals and Systems-System dynamics-Definitions of Signals and Systems-Representations of Signals and Systems-continuous-time,-discrete-time representations-measurements in dynamic systems; Example: cruise control-Laplace transform definition, properties-Block diagram algebra | 6/10/2016-1/11/2016 |
| PART II( MODELING OF MECHANICAL SYSTEMS) |
| * Modeling: one-dimensional mechanical components
* Modeling: impedance of mechanical components
* Modeling: rotational systems
* Example: rotational systems
* Modeling: two-port components
* Examples
 | 1/11/2016-20/1/2017 |
| PART III (ANALYSIS OF DYNAMIC SYSTEMS) |
| * Standard input functions: delta, step, ramp, and sinusoid
* Poles and zeros
* Standard 1st and 2nd order system responses
* Stability of equilibrium and determination of stability
 | 20/1/2017-11/3/2017 |
| PART IIII ( FEED BACK CONTROL SYSTEMS)  |
| * Properties and characteristics of feedback;
* Open-loop vs. closed-loop transfer functions; sensitivity; steady-state error;
* Disturbance rejection; PID Controllers;
* Performance of feedback control systems,
* Introduction to root-locus; steps for drawing root-locus.
* Examples of root-locus for PID controller design.
 | 11/3/2017- 10/05/2017 |

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| **18. Practical Topics (If there is any)** |  |
| In this section The lecturer shall write titles of all practical topics he/she is going to give during the term. This also includes a brief description of the objectives of each topic, date and time of the lecture  | Lecturer's nameex: (3-4 hrs)ex: 14/10/2016 |
| **19. Examinations:**Salahaddin University-Erbil Final Exam First Round Date: 30 June 2015 College of Engineering 2014-2015 Time: 3 hours  Mechanic Department Subject: Control System Class: Fourth Year Lecturer: Chalang H.Q1- Draw a Bode plot for the open loop transfer function *M*(*s*), indicate both *ωgc* and *ωpc.* Comment on your result. (20%)$$ M\left(s\right)= \frac{800}{s\left(s^{2}+12s +100\right)}$$Q2- Answer the followings for the galvanometer system depicted in Figure 1. Where *R* and *L* are the resistance and inductance of the galvanometer. The mechanical components of the galvanometer are *J*, *K* and *f*. 1. Specify dynamics in the transfer function form for each component (10%)
2. Find the system transfer function $\frac{θ(s)}{V(s)}$ (9%)
3. Find the system state space representation, such that *i*, *θ*, and *dθ*/*dt* as state variables, and *dθ*/*dt* as the output of the system. (11%)

*eb**θ*Figure 1 Galvanometer systemQ3- The open loop transfer function for the controller and plant can be represented as:$$Ge\left(s\right)=\frac{6.5K\_{p}}{\left(s+10\right)\left(s+4\right)\left(s+3\right)}$$ Answer the followings: 1. Determine the maximum permissible value (marginally stable) of gain *Kp*, based on the Nyquist criterion for stability. (10%)
2. What is the steady state error for a step input according part A (10%)
3. For what kind of input does the design in part A apply (5%)

Q4- Design the values of *Kr* and *Kd* in the block diagram of Figure 2, to meet the following specifications: Steady state error component due to a unit step disturbance is 0.000012; steady state error component due to a unit ramp reference is 0.003. (25%)Figure 2 |
| **20. Extra notes:**Here the lecturer shall write any note or comment that is not covered in this template and he/she wishes to enrich the course book with his/her valuable remarks. |
| **21. Peer review پێداچوونه‌وه‌ی هاوه‌ڵ** This course book has to be reviewed and signed by a peer. The peer approves the contents of your course book by writing few sentences in this section.*(A peer is person who has enough knowledge about the subject you are teaching, he/she has to be a professor, assistant professor, a lecturer or an expert in the field of your subject).*ئه‌م کۆرسبووکه‌ ده‌بێت له‌لایه‌ن هاوه‌ڵێکی ئه‌کادیمیه‌وه‌ سه‌یر بکرێت و ناوه‌ڕۆکی بابه‌ته‌کانی کۆرسه‌که‌ په‌سه‌ند بکات و جه‌ند ووشه‌یه‌ک بنووسێت له‌سه‌ر شیاوی ناوه‌ڕۆکی کۆرسه‌که و واژووی له‌سه‌ر بکات.هاوه‌ڵ ئه‌و که‌سه‌یه‌ که‌ زانیاری هه‌بێت له‌سه‌ر کۆرسه‌که‌ و ده‌بیت پله‌ی زانستی له‌ مامۆستا که‌متر نه‌بێت.‌‌  |